Chapter 6

Fuzzy Random Regression–Based Modeling in Uncertain Environment

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ABSTRACT

The parameter value determination is important to avoid the developed mathematical model is troublesome and may yield inappropriate results. However, estimating the weights of the parameter or objective functions in the mathematical model is sometimes not easy in real situations, especially when the values are unavailable or difficult to decide. Additionally, various uncertainties include in the statistical data makes common mathematical analysis is not competent to deal with. Hence, this paper presents the Fuzzy Random Regression approach to determine the coefficient whereby statistical data used contain uncertainties namely, fuzziness and randomness. The proposed methods are able to provide coefficient information in the model setting and consideration of uncertainties in the evaluation process. The assessment of coefficient value is given by Weight Absolute Percentage Error of Fuzzy Decision. It clarifies the results between fuzzy decision and non-fuzzy decision that shows the distance of different between both approaches. Finally, a real-life application of production planning models is provided to illustrate the applicability of the proposed algorithms to a practical case study.

INTRODUCTION

Real-world decision-making is often referred to rely on human judgment and consideration. Human contributes directly to the decision making process as many evaluations depend on human judgment, which is usually based on experience and intuition. The expression of accurate values in mathematical models has been a complicated problem yet the conventional theory of decision making and problem

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solving methodologies are developed within the crisp interpretation to obtain the best solution (Zeleny, 1981; Jones and Tamiz, 2010; Jubril, 2012, Vasant, 2012). However, research in decision making methodologies is influential to address the existence of uncertainties that are occurring naturally from the real problem or during the model setting. For example, the information available to a decision maker has been often imprecise because of inaccurate attribute measurements and inconsistency in priorities. Until recently, the decision-making process still utilized subjective judgments when considering human evaluations for certain cases, such as resource planning problems. Hence, it is crucial to embark upon uncertainty to obtain a feasible solution. For this reason, fuzzy sets (Zadeh, 1965) are useful for representing uncertain and imprecise information in mathematical programming, as fuzzy sets reflect these uncertainties and can therefore play a significant role in dealing with such circumstances. Thus, fuzzy programming is valuable for dealing with uncertainties for cases in which the problem model’s parameters cannot be estimated precisely from the real situation.

Interpreting uncertainties or incomplete information to the precise numerical values requires an appropriate approach that is difficult and stills a challenge (Zeleny, 1981; Inuiguchi et al., 1990; Bouyssou, 1989; Hasuike and Ishii, 2009). In practical systems, coefficient values should typically be considered to be uncertain values. The uncertainty arises in probability and/or vague situations, such as in cases of predictions of future profits, incomplete historical data, and/or replacement of decision makers, all of which result in uncertain information. Various approaches can be utilized to accommodate the uncertainty. For example, probability distribution, fuzzy numbers, and thresholds types (Bouyssou, 1989). Fuzzy sets (Zadeh, 1965) have made remarkable significant role and are useful for representing uncertain and imprecise information. Probability and possibility theories are also introduced to treat the random and fuzzy information, respectively. Such theories are significant to tackle uncertain information which exists apparently in real-world situation. Additionally, stochastic programming model (i.e., Dantzig, 1955; Sengupta, 1979) and the fuzzy programming model (i.e., Zimmermann, 1976; Zimmermann, 1978; Inuiguchi et al., 1990; Sakawa, 1993; Vasant, 2003; Vasant, 2010) has been introduced to address various real-world problems. The application of fuzzy set and possibility theories to decision-making allows decisions based on imprecise information. In linear programming, possibility theory can be used to include imprecise parameters in the problem formulation (Inuiguchi and Sakawa, 1996; Julien, 1994). Apparently, fuzzy theories and other related theory have made successful to work on the uncertainty problem in modeling and dealing with real world problem.

The elementary aspects of decision making are model setting and goal achievement. Developing a mathematical model from real world application should be carefully undertaken. The developed model is always an abbreviated view of an actual system and typically requires pre-determined and well-defined model parameters. Thus, determining the parameter values is important or the developed mathematical model may yield improper results. However, estimating the coefficient is influenced by the existence of uncertain information. That is, the uncertain information should be treated properly when estimating the coefficient. This is to avoid unawareness of important value presents in the uncertain information if such uncertainties didn’t being modeled properly (Inuiguchi and Sakawa, 1996; Möller et al., 2012; Dubois and Prade, 2012; Part et al., 2012). Decisions regarding these coefficients are crucial and influential for the accuracy of the model’s results, and the occurrence of errors in the determination of the model’s coefficients might ruin the model formulation.

Various fuzzy regression models have been introduced in the past centuries to address fuzzy data. A fuzzy regression model requires information from fuzzy statistics, fuzzy numbers, and/or fuzzy arithmetic (Watada and Tanaka, 1987; Tanaka et al., 1982). Possibilistic programming which describes